

ASU® Rob and Melani Walton
Sustainability Solutions Service
Arizona State University

2018 Community-Scale Greenhouse Gas Emissions Inventory

An executive summary
prepared for



City of Phoenix
April 2020

sustainabilitysolutions.asu.edu

Acknowledgements

This report is a joint effort by the City of Phoenix:

Nancy Allen, Environmental Programs Manager

Rosanne Albright, Environmental Programs Coordinator

Dr. Matthew Potzler, Environmental Air Quality and Climate Specialist

Joe Gibbs, Environmental Air Quality Specialist

And

Arizona State University's Walton Sustainability Solutions Initiatives:

Bill Campbell, Portfolio Manager

Mahindra Venkat, Graduate Student

And

Northern Arizona University's School of Informatics, Computing, and Cyber Systems

Dr. Richard Rushforth, Assistant Research Professor

We would like to recognize the financial support from Aviation, Public Works, Water and Transit Departments.

In addition, we wish to acknowledge the numerous city departments' staff for supplying the data needed to produce the *City of Phoenix 2018 Community Greenhouse Gas Emissions Inventory*.

Finally, we would like to thank City of Phoenix employees, residents, and business owners, who are on the ground supporting the city's efforts and who are working toward reducing their own greenhouse gas emissions.

Note: The data and calculations presented in this report may not be exact due to rounding errors within the GHG emissions template.

Acronym List

AFFA	Agriculture, Forestry, and Fishing Activities
AFOLU	Agriculture, Forestry, and Land Use
APS	Arizona Public Service
AR	IPCC Assessment Report (Numbered 2 through 5)
ASU	Arizona State University
AZNM	Arizona and New Mexico eGRID Subregion
B20 Biodiesel	Contains up to 20% biodiesel
BEV	Battery Electric Vehicle
BPEV	Batter Plugin Electric Vehicle
CH ₄	Methane
CNG	Compressed Natural Gas
CO ₂	Carbon Dioxide
CO ₂ e	Carbon Dioxide Equivalent Emissions
E54	Fuel containing 54% ethanol
E85	Fuel containing 85% ethanol
eGRID	EPA's Emissions and General Resource Integrated Database
EIA	U.S. Energy Information Administration
EPA	U.S. Environmental Protection Agency
EV	Electric Vehicle
FERC	Federal Energy Regulatory Commission
FTE	Full-time equivalent
GGE	Gasoline Gallon Equivalent
GHG	Greenhouse Gas
GPC	Global Protocol for Community-Scale GHG Emission Inventories
GWP	Global Warming Potential
ICLEI	International Council for Local Environmental Initiatives,
IE	Included Elsewhere
IPPU	Industrial Processes and Product Use
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MPST	Mining, Processing, Storage, and Transport of Coal
MT	Metric Tons
MWh	megawatt-hour
NAU	Northern Arizona University
NE	Not Estimated
NERC	North American Electric Reliability Corporation
NO	Not Occurring
N ₂ O	Nitrous Oxide
ONGS	Oil and Natural Gas Systems
PNM	Public Service Company of New Mexico
SRP	Salt River Project
T&D	Transmission & Distribution
TRP	Trip Reduction Program
WECC	Western Electricity Coordinating Council
WWT	Wastewater Treatment
WWTP	Wastewater Treatment Plant

Executive Summary

The City of Phoenix (City) has completed a community-scale greenhouse gas (GHG) emissions inventory for calendar year 2018. The 2018 community-scale GHG emissions inventory was conducted using the Global Protocol for Community-Scale GHG Emission Inventories (GPC). The GPC is a worldwide standard for inventorying city-induced GHG emissions developed by the World Resources Institute, C40 Cities Climate Leadership Group, and ICLEI¹. The GPC is also the standard supported by the Global Covenant of Mayors for Climate and Energy, of which the City is a member.

The GPC categorizes direct and indirect GHG emissions into three sectors: Stationary Energy, Transportation and Waste. Direct GHG emissions occur within City boundaries, while indirect GHG emissions are induced by activity within the City boundary.

- The Stationary Energy Sector includes GHG emissions that occurs from energy utilized in residential buildings, commercial buildings and facilities, manufacturing industries, agriculture, forestry and fishing energy use, and electricity transmission and distribution energy losses.
- The Transportation Sector includes GHG emissions from commercial and civil aviation, on-road transportation, non-road vehicle use, freight and light rail.
- The Waste Sector includes GHG emissions from solid waste disposal, the biological treatment of waste (composting), and wastewater treatment.

The 2018 community-scale GHG inventory is the third completed by the City following the 2012 and 2016 2018 community-scale GHG inventories. While each of the community-scale GHG inventories completed by the City have followed the GPC, during each inventory process the previous year(s) GHG inventory have been recalculated to reflect updates to source data, data collection and processing methods, GHG global warming potentials, GHG emissions estimation methods. Changes to GHG emissions totals for the 2012 and 2016 calendar years are reported along with the 2018 GHG emissions totals.

Key Findings

- In 2018, community-scale GHG emissions were 16,603,754 metric tons of carbon dioxide equivalents (MT CO_{2e})
- 2018 community-scale GHG emissions were 0.5% lower than the 2012 levels of 16,692,626 MT CO_{2e} (Figure ES-1).
- Stationary Energy Sector GHG emissions totaled 8,550,631 MT CO_{2e}.

¹ Greenhouse Gas Protocol. (n.d.). GHG Protocol for Cities | Greenhouse Gas Protocol. Retrieved from <http://www.ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities>

- Transportation Sector GHG emissions totaled 7,748,914 MT CO₂e.
- Waste Sector GHG emissions totaled 304,209 MT CO₂e.
- GHG emissions decreased during a period where the City’s population grew 12% and the metro area economy grew 26%. Per capita emissions fell from the 2012 baseline of 11.33 MT CO₂e to 10.00 MT CO₂e in 2018.

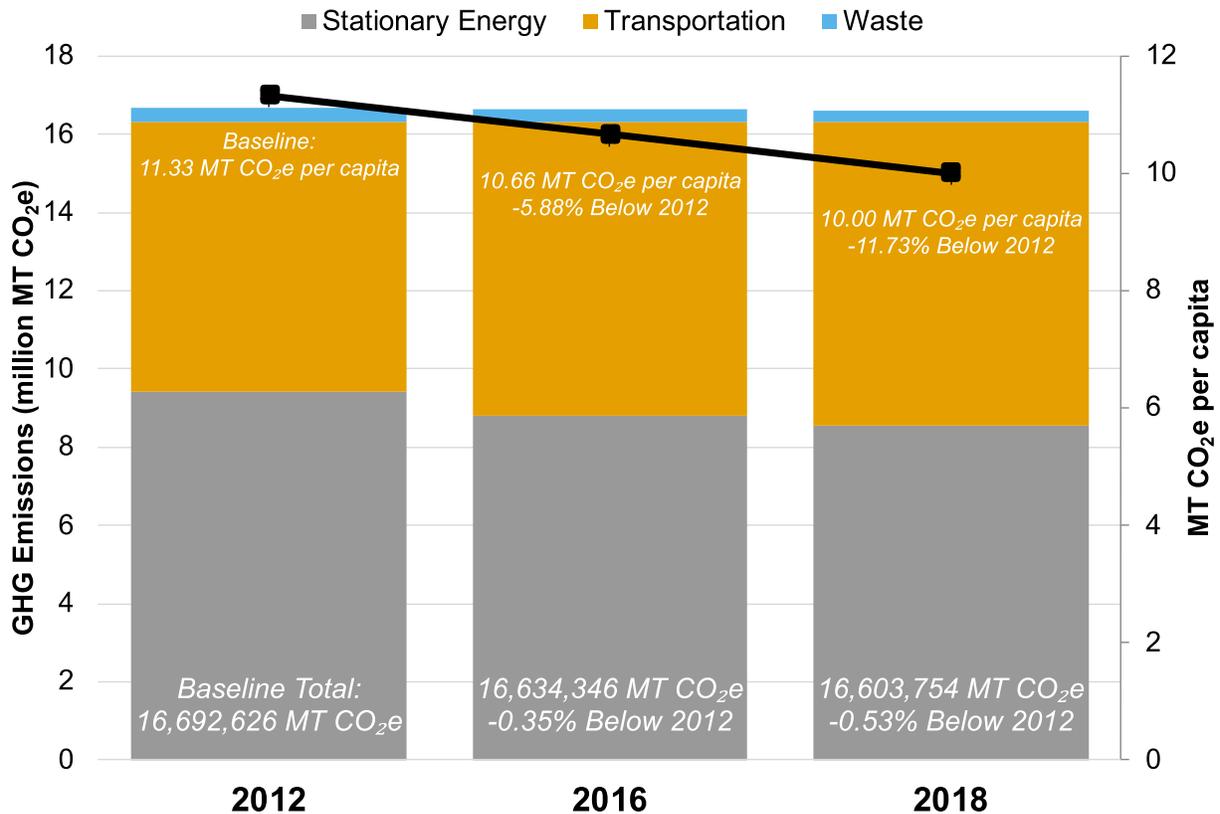


Figure ES-1. GHG emissions by emissions sector for 2012, 2016, and 2018.

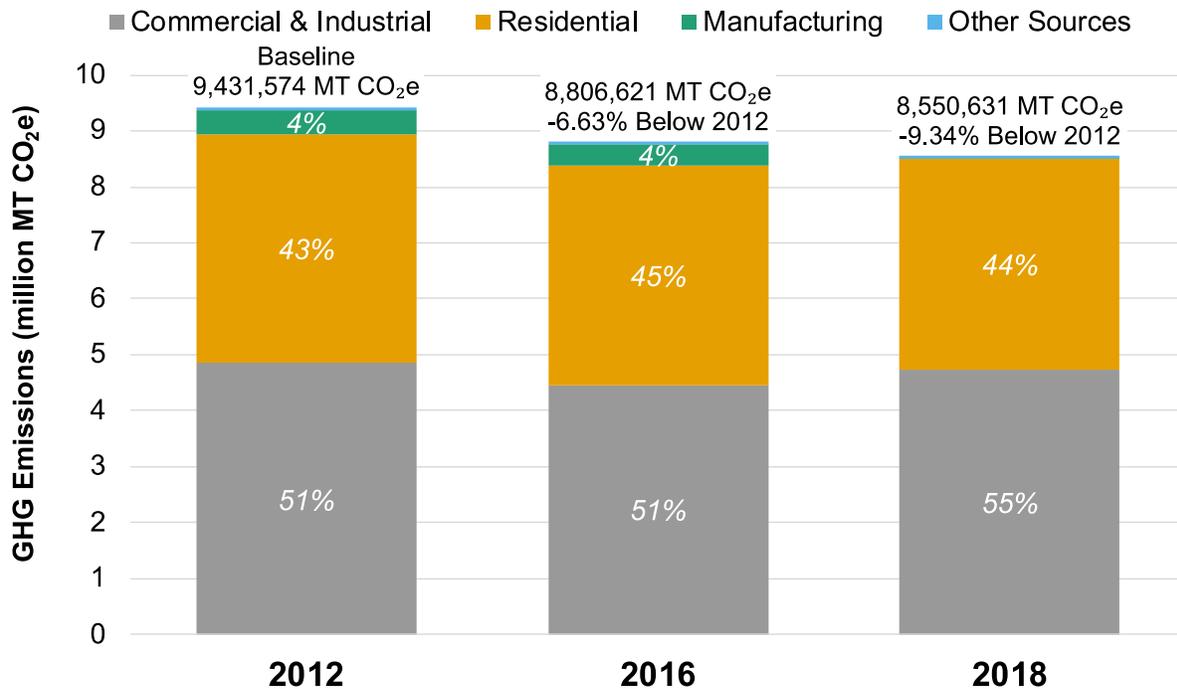
The distribution of GHG emissions between Stationary Energy, Transportation, and Waste Sectors for 2012, 2016, and 2018 is detailed in Table ES-1.

Table ES-1. Phoenix GHG emissions by Sector (MT CO₂e)

Sector	2012	2016	2018	% Change 2012 -2018
Stationary Energy	9,431,574	8,806,621	8,550,631	-9.3%
Transportation	6,895,031	7,514,844	7,748,914	12.4%
Waste	366,021	312,881	304,209	-17.6%
Total	16,692,626	16,634,346	16,603,754	-0.5%

Stationary Energy

The Stationary Energy Sector is the largest source of GHG emissions in the City. Stationary energy GHG emissions sources include energy utilized in residential buildings; commercial buildings and facilities; manufacturing industries; agriculture, forestry and fishing energy use; and electricity transmission and distribution energy losses. GHG emissions from natural gas leakages were not included for any reporting year due to a lack of data on leakage rates.



Residential - Residential buildings; Commercial & Industrial - Commercial and institutional buildings and facilities; Manufacturing - Manufacturing industries and construction; Other Sources - Agriculture, forestry, and fishing activities and Non-specified sources.

Figure ES-2. Stationary Energy GHG emissions for 2012, 2016, and 2018.

Stationary Energy GHG emissions for 2018 were 8,550,631 MT CO₂e, which is a 9% decrease in emissions from 2012. The driving force behind the large reduction in Stationary Energy GHG emissions resulted from a regional increase in clean energy production, which decreased the carbon intensity of what Phoenix consumes, as reflected in the EPA Emissions and General Resource Integrated Database (eGRID) GHG emissions factor. Data to calculate Stationary Energy GHG emissions were obtained from Arizona Public Service (electricity), the Salt River Project (electricity), Southwest Gas (natural gas), and the Energy Information Administration (electricity transmission and distribution loss). Figure ES-2 shows the distribution of GHG emissions between different sub-sectors in the Stationary Energy Sector for 2012 and 2018 and Table ES-2 details the GHG emissions by subsector.

Table ES-2. Subsector Stationary Energy GHG Emissions (MT CO₂e)

Stationary Energy	2012	2016	2018	% Change 2012-2018
Residential Buildings	4,093,258	3,940,954	3,755,614	-8%
Commercial & Institutional Buildings	4,853,598	4,449,184	4,740,164	-2%
Manufacturing Industries & Construction	415,704	364,647	8,303	-98%
Agriculture, Forestry & Fishing Activities	68,954	51,758	46,477	-33%
Non-Specified Sources	60	78	74	23%
Total	9,431,574	8,806,621	8,550,631	-9%

Transportation

The Transportation Sector is the second largest source of GHG emissions in Phoenix. Transportation GHG emissions sources occur from commercial air travel, civil aviation, on-road transportation, non-road vehicle use, light rail, and freight rail. GHG emissions result from the combustion of fossil fuels (gasoline, diesel, CNG, LNG, LPG, aviation gasoline, jet fuel A), blended alternative fuels (B20 biodiesel, E85 Ethanol, E54 Ethanol), or indirectly through the consumption of electricity to charge electric vehicles. Transportation GHG emissions for 2018 were 7,748,914 MT CO₂e, a 12% increase in GHG emissions from the 2012 level of 6,895,031 MT CO₂e (Figure ES-3).

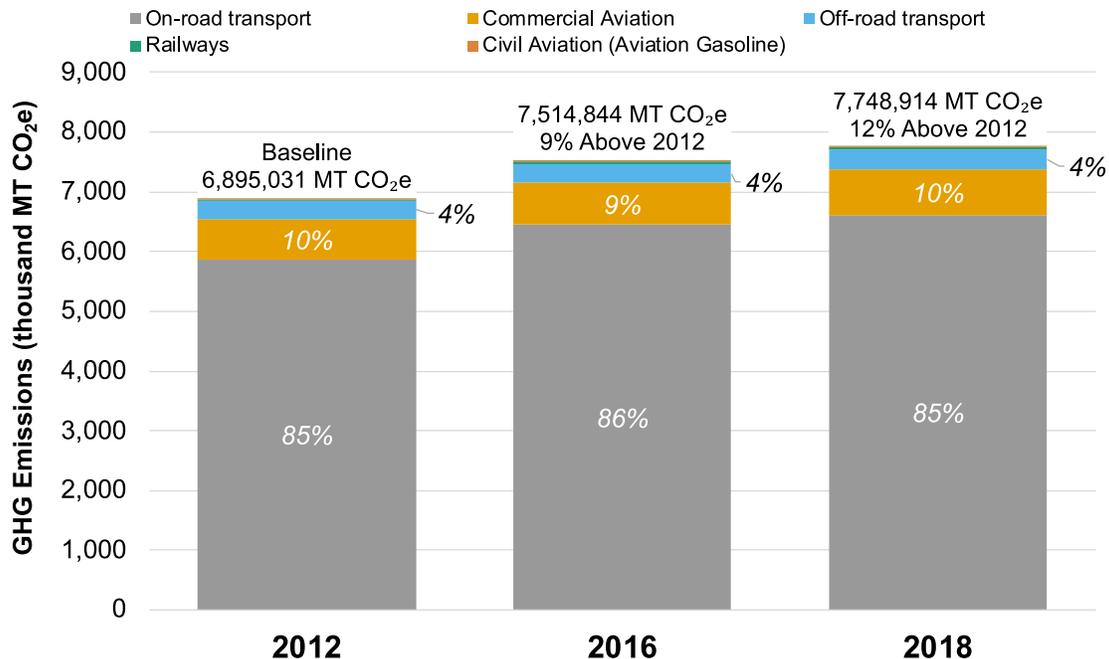


Figure ES-3. Transportation GHG emissions for 2012, 2016, and 2018.

Increased on-road and off-road transportation activity was responsible for the increased emissions. Data were obtained from the City of Phoenix, Arizona Department of Transportation, the Weights and Measures Division of the Arizona Department of Agriculture, the Federal Aviation Administration, and Southwest Gas. Table ES-3 details GHG emissions among Transportation sub-sectors for the years 2012, 2016, and 2018.

Table ES-3. Subsector Transportation GHG Emissions (MT CO₂e)

Transportation	2012	2016	2018	% Change 2012-2018
On-road transport	5,856,023	6,444,711	6,601,864	13%
Railways	29,113	29,300	31,541	8%
Commercial Aviation	698,263	705,643	779,113	12%
Civil Aviation (Aviation Gasoline)	13,394	15,067	10,043	-25%
Off-road transport	298,237	320,122	326,353	9%
Transportation Sector Total	6,895,031	7,514,844	7,748,914	12%

Waste

The Waste Sector includes emissions from the current and historic disposal of solid waste generated and treated in Phoenix, the current disposal of solid waste generated in Phoenix that is disposed outside the city, wastewater treated at the 91st Avenue and 23rd Avenue wastewater treatment plants in Phoenix, and the biological treatment (composting) of waste generated and treated in Phoenix. Between 2012 and 2018 there was a 17% decrease in Waste Sector GHG emissions. GHG emissions from solid waste disposal decreased by approximately 19%, similar to the Waste Sector overall (Table ES-4). GHG emissions from wastewater treatment increased by 21% and composting increased 40%. The total GHG emissions from the Waste Sector were 304,209 MT CO₂e in 2018 as compared to 366,021 MT CO₂e reported in the 2012. Waste Sector reductions were driven by solid waste disposal, which is more than 90% of the sector emissions. While Solid Waste GHG emissions will occur from the ongoing disposal of solid waste, historic, closed landfills within the City of Phoenix would produce less GHG emissions over time as the waste decays.

Table ES-4. Subsector Waste Sector GHG Emissions (MT CO₂e)

Waste	2012	2016	2018	% Change 2012-2018
Solid Waste Disposal	351,780	299,484	285,885	-19%
Wastewater Treatment & Discharge	8,440	9,428	10,199	21%
Biological Waste Treatment (Composting)	5,802	3,968	8,125	40%
Waste Sector Total	366,021	312,881	304,209	-17%

Conclusion

In 2018, citywide GHG emissions in Phoenix was 16,603,754 metric tons CO₂e – 0.5% below the 2012 levels of 16,692,626 MT CO₂e. Emissions increased in the Transportation Sector by 853,883 MT CO₂e, which was proportional to population growth. Stationary Energy GHG emissions decreased 880,943 MT CO₂e, driven by a less GHG-intensive regional electricity grid. Waste Sector GHG emissions decreased by 17% between 2012 and 2018, but are small compared to the Stationary Energy and Transportation sectors. While Solid Waste GHG emissions will occur from the ongoing disposal of solid waste, closed landfills within the City produce less GHG emissions as the waste decays.

The Transportation Sector is the second largest source of GHG emissions in Phoenix and grew by 853,883 MT CO₂e between 2012 and 2018. On-road transportation, mainly gasoline consumption, drove Transportation Sector GHG emissions increase. Measures to reduce transportation-related GHG emissions will reduce community-scale GHG emissions. Gasoline-powered motor vehicles used for on-road transportation is the largest single source of transportation-related GHG emissions. An increased adoption of battery electric vehicles (BEVs) or plugin electric hybrid vehicles (PEHVs) is one avenue to reduce transportation-related GHG emissions. Another is higher adoption rate of mass transit options.